Correlating Flammability of Materials with FTIR Analysis Test Results

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PURPOSE: Correlate flammability data with FTIR test results.

MATERIAL: Kydex 100 is a blend of chlorinated polyvinyl chloride and polymethylmethacrylate, with some filler materials. Samples supplied were 0.125" thick.

METHOD: 10 samples were taken from a sheet of Kydex and analyzed for flammability and by FTIR spectroscopy.

ADDITIONAL INFORMATION: This material was utilized as a round robin sample for flammability testing per NASA–STD–6001 (formerly NHB 8060.1c, Test 1), performed at the Materials Combustion Research Facility at MSFC. The flammability test results were found to vary across the same sheet.

FTIR Internal Layout

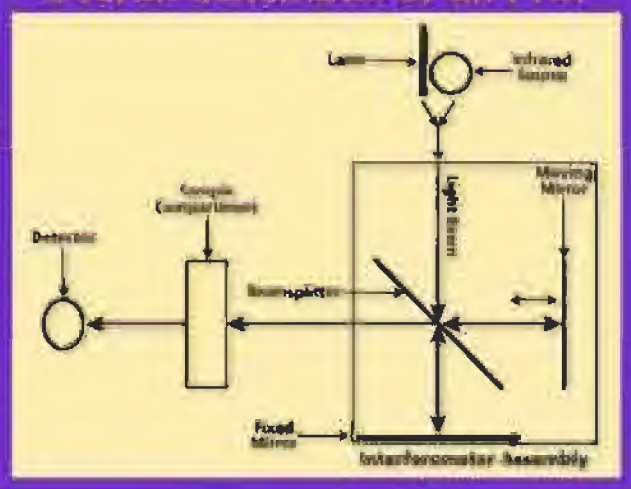
FTIR Spectrometer

BASIC FTIR PRINCIPLE

- An infrared light source induces vibrations within the molecules of a sample.
- Different molecular functional groups generate characteristic peaks within the infrared spectra. These peaks assist in identification of the molecule.

The infrared source beam is split in two parts by the beamsplitter and then recombined. The difference in the signal generated in the fixed mirror and moving mirror produces a signal called an interferogram. The recombined beams shine back through the beamsplitter, then through the sample. The interferogram generated is Fourier Transformed (a mathematical operation). This generates a spectral signature unique to that sample. The laser is used to calibrate the wavelength. The detector converts the infrared signal into an electrical signal.

Overall Schematic of an FTIR



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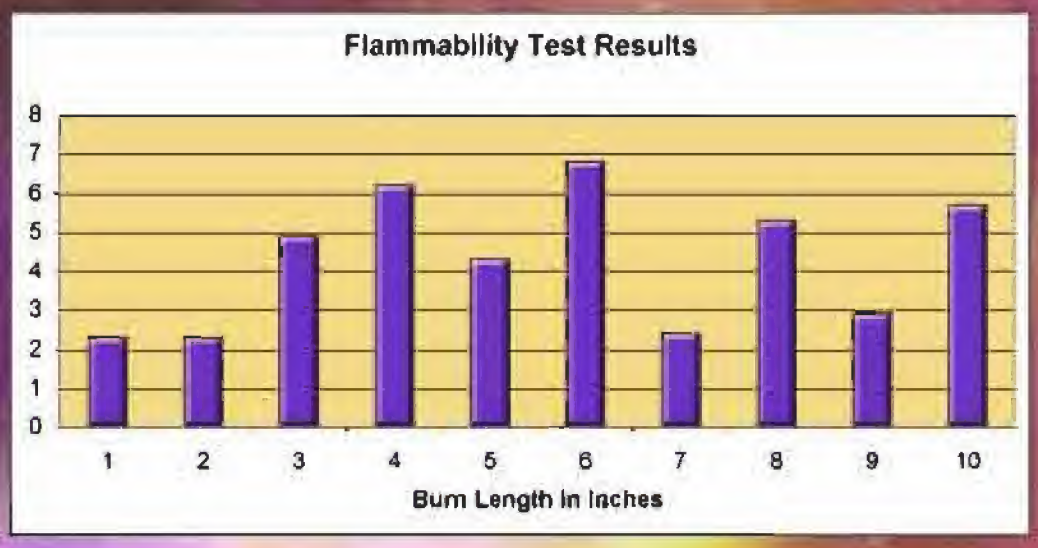
Each 24"x 48" sheet was cut into 2.5"x 12" pieces for flammability testing. The adjoining pieces were cut into pieces 2.5"x 1" for the FTIR analysis, so the FTIR samples could be directly compared with the flammability samples.

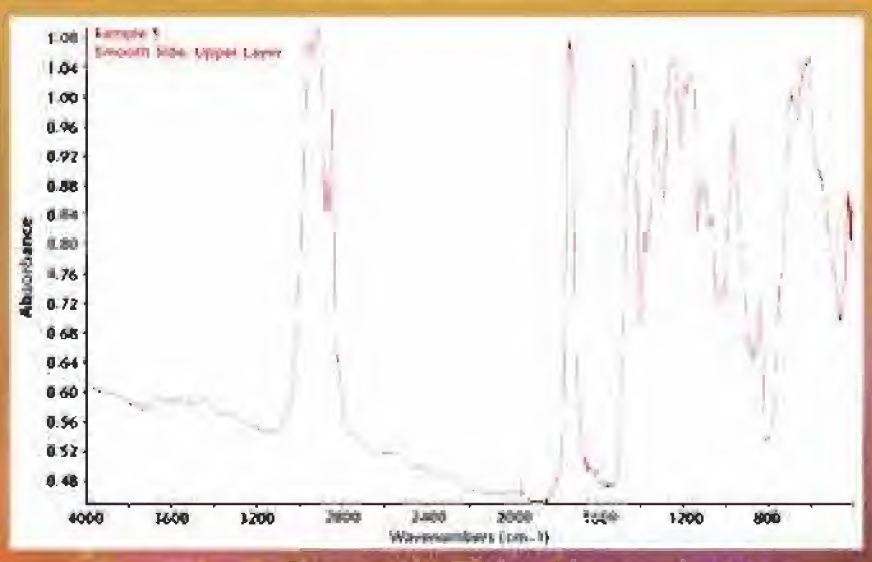


FTIR Sample Preparation Methods:

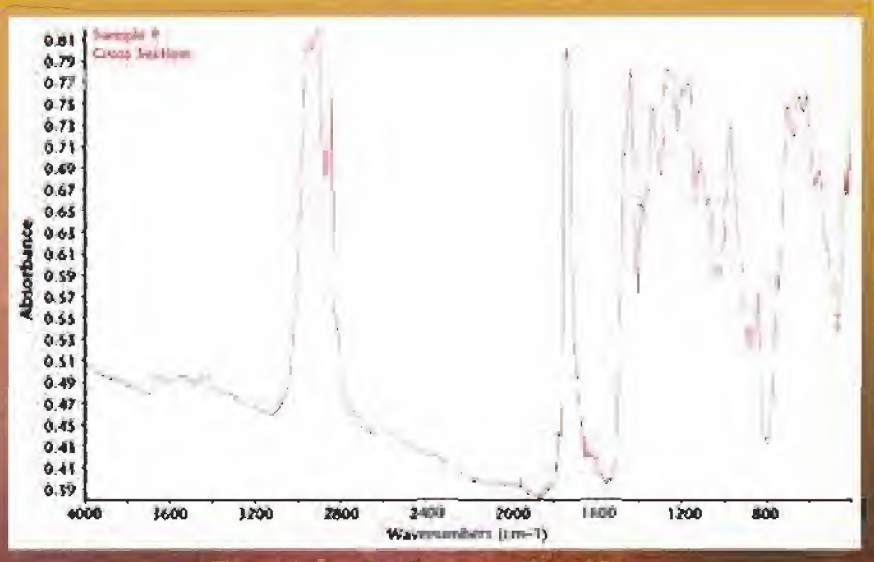
1. Cut out thin sections with diamond-tipped knife to plane off thin sections of the material, which were then pressed to the correct thickness.

2. Cut out small cubes with scissors and press a cross section of the sample several times until attaining the right thickness.

FTIR DATA RESULTS



Sample 5, Smooth Side, Upper Layer



Sample 9, Cross Section

Communication with the manufacturer revealed no apparent reason for the variations in flammability. There was speculation that an unknown organotin (concentration 0.1%–3.0%) could cause the variations; however, there was no obvious spectroscopic clue that an organotin was present. After running different areas of each sample numerous times, the samples appeared to be homogenous with very few differences among different portions of the Kydex sheet.
It is possible that an instrument equipped with an infrared hyperspectral array detector could be more suited to this type of screening procedure. This type instrument, instead of a single detector, has hundreds of detector elements, which could provide a rapid scan of the entire exterior of a sample.

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